

A taxonomic revision of S. E. Asian *Chaetocarpus* Thwaites (Euphorbiaceae)

P. C. van Welzen

Rijksherbarium/Hortus Botanicus, P. O. Box 9514, 2300 RA Leiden,
The Netherlands

Abstract

The genus *Chaetocarpus* contains 10 or 11 species and is found pantropically. In SE Asia only one species is found, *C. castanocarpus* (Roxb.) Thwaites. Typical for *C. castanocarpus* are the clusters of axillary flowers, the absence of petals, the stamens united into an androphore, the fruits with glochidiate hairs, and the arillate seeds. This species is widespread and is found in Ceylon and India and in SE Asia (Burma, Cambodia, Vietnam, Thailand, Malaysia, Sumatra and Borneo).

INTRODUCTION

In SE Asia the genus *Chaetocarpus* is readily recognizable by its echinate fruits with glochidiate hairs, the black, arillate seeds, the absence of petals, axillary clusters of flowers, and the stamens united into an androphore. The hairs on the fruits detach easily from the exocarp and remain stuck to the skin, where the free part often breaks off, leaving an ulcerating tip in the skin.

Thwaites described the genus in 1854. He only recognized one species (*C. pungens*), and found out later (Thwaites, 1861), that it is conspecific with the older *Adelia castanocarpa* described by Roxburgh (1832). Thwaites (1861) also described a new species (*C. coriaceus*) and a new variety (*C. castanocarpus* var. *pubescens*) for Sri Lanka. Hooker (1887) raised the latter variety to specific rank. *C. coriaceus* is readily recognizable by its different type of fruit, which is much larger than those of the other two species and which lacks the stinging hairs and looks scaly. *C. pubescens* is much more hirsute than the other two species, while the leaves differ in shape from those of *C. castanocarpus*.

Later on, more species were described for the other tropical regions in the world, one for Africa and several for S America. Marcus Alves is presently undertaking a revision of the complete genus. Therefore, this revision is limited to the SE Asian specimens only, contributing to the Flora Malesiana Project.

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In SE Asia only one species is present, *Chaetocarpus castanocarpus* (Roxb.) Thwaites. This species is widespread, but with a few disjunct areas in the western part of its distribution. It is known from Sri Lanka and India and from SE Asia (Burma, Andamans, Cambodia, Vietnam, Thailand, Malaysia, Sumatra, Borneo). Three specimens from New Guinea (E. Malesia) were also identified as *Chaetocarpus*. One of them, *Anta* 528 (L), is probably erroneously recorded for New Guinea, due to a switch of labels, as the specimen is typical for Sumatra, where the collector has worked also. *Kanehira & Hatusima* 11548 (A, BO), labelled as a new species, is a misidentification, but as the plant has very young buds it can only be identified as *Drypetes* species, (courtesy of Max van Balgooy). The third specimen, *Docters van Leeuwen* 10234 (L), is the most interesting, because this specimen, which is sterile with a few fruit segments in a separate envelope, resembles the Sri Lanka species *C. pubescens* very closely. The collector mainly collected in New Guinea and never in Sri Lanka. However, because the material is very poor and no other specimens are known (n.b. *Chaetocarpus* is very well collected in its whole distribution range) seemingly something exceptional has happened. Therefore, the specimen is only provisionally assigned to *C. pubescens*, but no taxonomic decision has been made and, consequently, the species is still not regarded as belonging to the Malesian flora.

Pax (1890) places *Chaetocarpus* in the subfamily Crotonoideae tribe Gelonieae, together with 7 other genera (one ovule per locule, imbricate sepals, no petals, flowers in axillary bundles), but separate from the genus *Trigonopleura* (idem, with petals). The difference in petals is only relative. Often male flowers of *C. castanocarpus* are found with one (or two) tepal(s) inside the sepals. These can be interpreted as extra sepals, but because they are thinner the first impression is one of petals. Due to the special floral and fruit structure, Airy Shaw (1975) places *Chaetocarpus* separate from the Crotoneae, in the Chaetocarpeae, an informal rank, together with *Trigonopleura*. The latter genus indeed resembles *Chaetocarpus* and they are often confused with each other. Pax tends to stretch similarities, while Airy Shaw emphasizes the differences. Without a sound phylogenetic analysis, for which it is yet much too early, no choice between these two opinions can be made.

SYSTEMATIC TREATMENT

Chaetocarpus Thwaites

Thwaites, Hooker's J. Bot. Kew Gard. Misc. 6: 300. 1854; Baill., Et. Gen. Euph. 323. 1858; Thwaites, Enum. Pl. Zeyl. 274. 1861; Mull. Arg. in DC., Prod. 15, 2: 1121. 1866; Kurz, For. Fl. Br. Burma 2: 408. 1877; Hook. f.,

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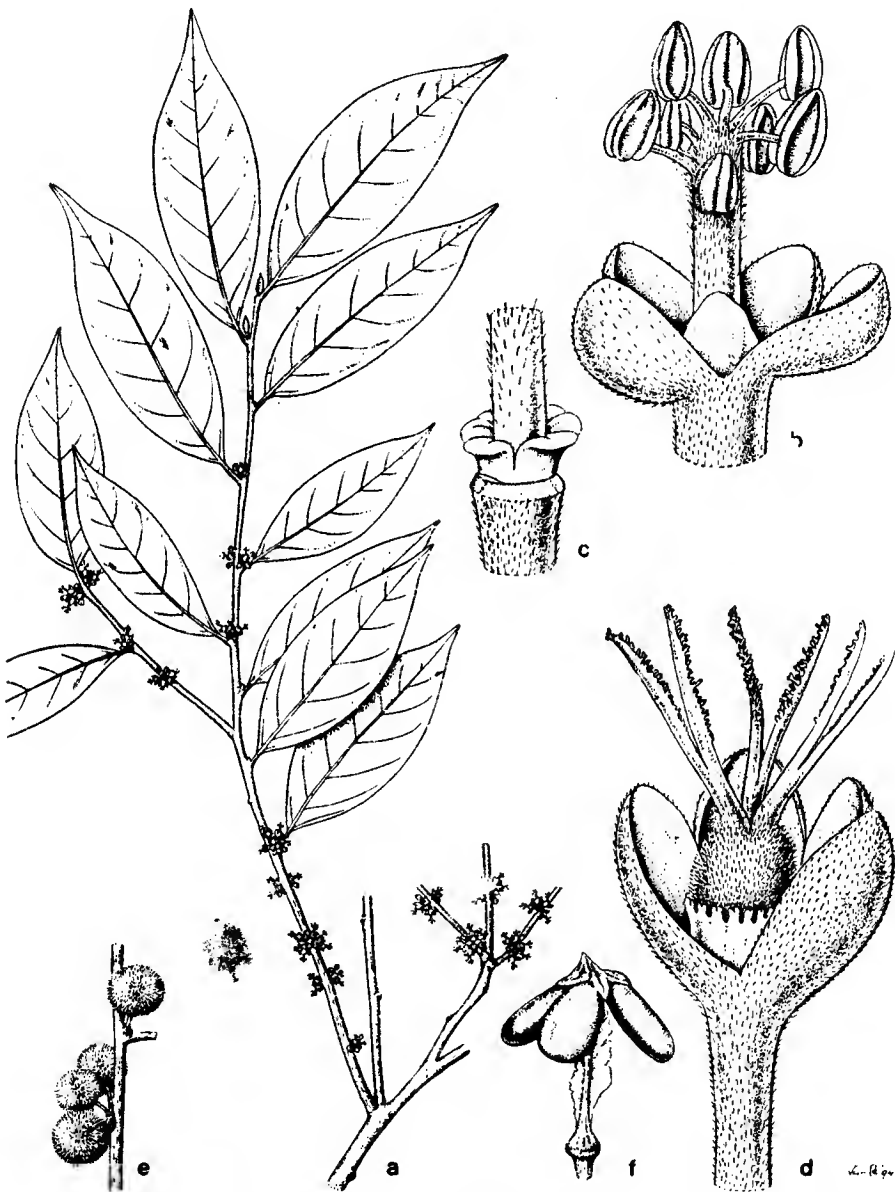


Fig. 1 *Chaetocarpus castanocarpus* (Roxb.) Thwaites: a. habit, x 0.5; b. male flower showing petal or fifth sepal, x 12.5; c. male flower without sepals showing disc around androphore, x 12.5 (a—c: Ambri & Arifin W 901, L); d. female flower, x 12.5 (SAN (Gibot) 35970, L); e. fruits with stinging hairs, x 0.5 (Simpson 2009, L); f. seeds with basal aril, x 3 (SAN (Lantoh) 73395, L).

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Fl. Brit. India 5: 460. 1887; Pax in Engl. & Prantl, Nat. Pflanzenfam. 3, 5: 89. 1890 & Nat. Pflanzenfam. Nacht. II-IV. Teil: 212. 1897; Craib, Contr. Fl. Siam, Aberdeen Univ. Stud. 57: 194. 1912; Pax & K. Hoffm. in Engl., Pflanzenr. IV, 147, 4: 7. 1912; Ridl., Fl. Malay Pen. 3: 310. 1924; Gagnep. in Lecomte, Fl. Gen. I.-C. 5: 471. 1926; Airy Shaw, Kew Bull. 26: 231. 1972; Whitmore, Tree Fl. Malaya 2: 76. 1973. Airy Shaw, Kew Bull. Add. Ser. 4: 67. 1975 & Kew Bull. 36: 275. 1981.

Type species: *Chaetocarpus pungens* Thwaites [= *Chaetocarpus castanocarpus* (Roxb.) Thwaites]

Regnaldia Baill., *Adansonia* 1: 187. 1860; Mull. Arg. in DC., Prod.: 15.2 1257. 1866.

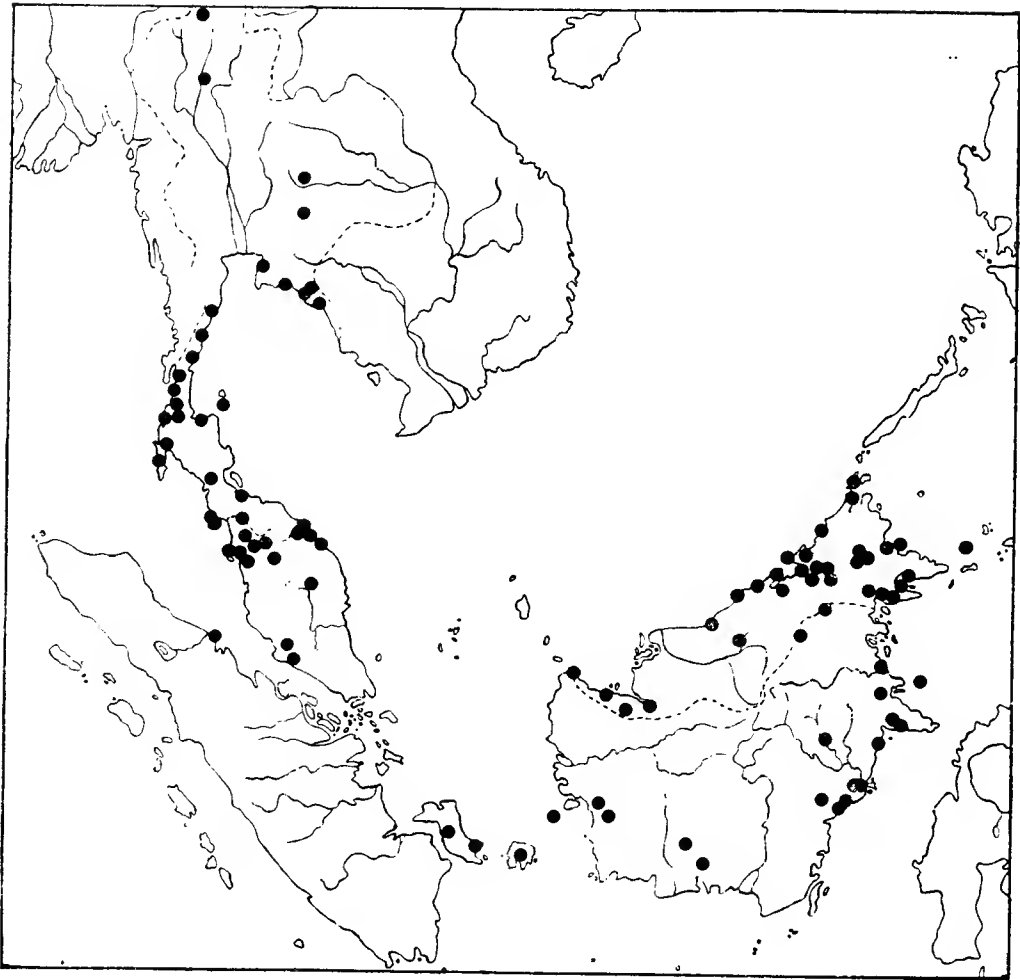
Type species: *Regnaldia cluytioides* Baill. [= *Chaetocarpus castanocarpus* (Roxb.) Thwaites].

Tree or shrub, dioecious. Stipules very asymmetric, early caducous. Leaves simple, distichous; petiole not or slightly pulvinate; blade (a) symmetric, coriaceous, punctate; base broadly attenuate; margin entire to laxly sinuate; apex acuminate to cuspidate; both surfaces (sub) glabrous; venation pinnate, looped and closed at the margin, indistinctly reticulate. Inflorescences dense axillary clusters of flowers (reduced thyrses), brachyblasts increasing in size with age. Bracts on brachyblasts 4 surrounding each flower. Pedicels in male flowers with break-zone halfway, elongating in fruit in female flowers. Flowers actinomorphic. Sepals 4 (or 5), 2 outside (outside sericeous), and 2 (or 3; see note) inside (outside with central sericeous band), spreading horizontally or reflexed, inside glabrous, third inner sepal petal-like, often with claw. Petals absent (see note). Disc annular, lobed, toothed, teeth in female flowers more numerous and narrower. Stamens absent in female flowers (see note 2); in Malesia male flowers with an androphore from which the filaments branch alternately, each with an anther except for one of the lower branches with often 2 or 3 anthers. Anthers 8—15, basifixed, opening laterally with a slit, bent upwards. Pistillodea pilose, 3-lobed. Pistil in female flowers on short gynophore, ovary 3- (or 4-) locular, densely hirsute; ovules one per locule, descending, epitropous, anatropous, attached halfway to column; styles 3, short, hirsute; stigmas divided up to the style, above with dendritic papillae, on lower surface hirsute. Fruit a rhegma, subglobose, in Malesia densely echinate with glochidiate hairs, outside, glabrous, inside dehiscing septicidally into 3 (or 4) segments, latter almost split to the base; wall thin, woody. Seeds ovoid, flattened, 1—3 per fruit, black, glossy, covered in upper third by a thin aril; endosperm absent.

Distribution: 10 or 11 species pantropical, one species in *W. Malesia*.

Note: The third (and very seldom a fourth) inner sepal is placed within the

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Map 1. Distribution of *Chaetocarpus castanocarpus* (Roxb.) Thwaites

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other two sepals and is alternisepalous and thinner than the sepals. Therefore, it might as well be described as a petal (see also fig. 1b). Petals are reported to be absent in *Chaetocarpus* and this character is considered to be the main difference with the genus *Trigonopleura*. Obviously, the difference between both genera is not in the complete absence or presence of petals, but in the reduced number of petals in *Chaetocarpus*.

Chaetocarpus castanocarpus (Roxb.) Thwaites Enum. Pl. Zeyl. 275. 1861; Mull. Arg. in DC., Prod. 15: 112. 1866; Kurz, For. Fl. Br. Burma 2: 409. 1877; Hook. f., Fl. Brit. India 5: 460. 1887; Gamble, Man. Ind. Timbers 623. 1902; Craib, Contr. Fl. Siam, Aberdeen Univ. Stud. 57: 194. 1912; Pax & Hoffm. in Engl., Pflanzenr. IV, 147, 4: 8. 1912; Ridl., Fl. Malay Pen. 3: 310. 1924; Gagnep. in Lecomte, Fl. Gen. 1.-C. 5: 471. fig. 59: 12—16. 1926; Corner, Ways. Trees Malaya 1: 244 ('*castaneicarpus*'). 1940; Airy Shaw, Kew Bull. 36: 275. 1981; Jarvie & Perumal, Tropics 3: 159. 1994.

Adelia castanicaarpa Roxb., Fl. Ind. 3: 848. 1832.

C. castanocarpus (Roxb.) Thwaites var. *genuina* Mull. Arg. in DC., Prod. 15. 1122. 1866, *nom. inval.*

Gadeawakka castanocarpa (Roxb.) Kuntze, Rev. Gen. 2: 606. 1891, *nom. superfl.* (see note 1).

Type: *Icones Roxburghianae* (K, holo), India, Bengal, Boolkokra.

Chaetocarpus pungens Thwaites, Hooker's J. Bot. Kew Gard. Misc. 6: 301, fig: 10A: 1—5, p.p., excl. description of fruit + fig. 10A: 6—9 (Thwaites, 1861). 1854.

Type: *CP (Thwaites)* 2641 (K, holo, n. v.; iso in L, UC), Ceylon.

Regnaldia cluytioides Baill., Adansonia 1: 188, pl. VII: 7, 8 1860; Mull. Arg. in DC., Prod.: 1257. 1866.

Type: *Walker s.n.* 1846 (P, holo, n.v.), Ceylon.

Bradleia? coriacea: Wall., Cat.: 7872. 1847, based on *Wallich* 7872 (BM, K, NY), Malaysia, Penang, *nom. nud.*

Casearia? coriacea: Wall., Cat.: 7196. 1847, based on *Wallich* 7196 (K, L), *nom. nud.*

Tree (or shrub) up to 45 m high, girth up to 3 m, d.b.h. up to 60 cm; buttresses usually absent or indistinct, up to 1.2 m long, c. 75 cm thick; flowering branches 1—4 mm thick. Indumentum consisting of simple, hirsute to sericeous hairs, glabrescent. Outer bark (smooth to) flaky, finely fissured, peeling off in 1—2 cm wide strips, coarsely granular, white to brown-grey to reddish brown to deep purple-brown, up to 2 mm thick; inner hard, gritty, salmon to red to purplish brown, up to 1 cm thick; cambium white to pale yellow. Sapwood white to yellow-brown; heart wood pale reddish brown. Leaves: stipules falcate, 3—6.5 by 0.6—2.2 mm, subglabrous to subsericeous; petiole 3—17 mm

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long, reniform in transverse section, with grooves across; blade ovate (to elliptic), 3.5—18.5 by 1.5—8 cm, index 1.8—3.5, apex narrowly rounded to mucronulate, nerves 7—9 per side. Inflorescences densely hirsute. Bracts triangular, c. 0.8 by 1 mm. Flowers greenish-yellow to white-yellow to yellow, slightly fragrant; male flowers 2.2—3.7 mm in diam.; female flowers up to 7.5 mm in diam. Pedicels woolly, in male flowers 3.8—4.6 mm long, in female flowers 3.3—5 mm long. Sepals ovate to rounded, 1.5—3 by 1.5—3.3 mm. Disc pink to red. Stamens in male flowers: androphore 2.8—5 mm long, hairy, white; filaments 0.4—1 mm long; anthers triangular to elliptic, 0.5—1.2 by 0.4—0.6 mm, (hairy), yellow. Pistil in female flower: gynophore up to 0.4 mm high; ovary ovoid, 1—1.3 mm high; styles 3, 0.3—1.2 mm long; stigma lobes 1—2 mm long. Fruit 8—18 mm across yellow turning reddish brown, glochidiate hairs c. 3 mm long. Seeds 5.2—5.5 by 3.5—5 by 2.7—3.5 mm; aril red. Embryo ovoid, flattened, c. 4.3 by 3 mm; plumule and radicle c. 0.7 mm long.

Distribution: Sri Lanka, India, (Assam, Andamans) Burma, Cambodia, Vietnam, Thailand and W. Malesia Malay Peninsula (not recorded for Singapore), Sumatra, and Borneo (Brunei, Kalimantan, Sabah, Sarawak). The New Guinean specimens are regarded to be misidentifications or the result of label switches. See map 1.

Ecology and habitat: Often common, but scattered in (hilly) primary and secondary lowland forest, mixed dipterocarp forest, coastal peat-swamp forest (kerangas), seasonal swampy forest, *Schima*-bamboo forest, along beaches and river banks, and in submontane scrubs. Soil: yellow, brown or black sandy soil, sandy loam, sandstone, yellow clay, clay-loam, rocky coral, or granite. Alt. sea level up to 500 m. (Partly after Airy Shaw, 1972, 1975, 1981). According to Whitmore (1973) a calcifuge, because it is common along the coast in NE Malaysia and the inland collections may reflect old Pleistocene shore lines. However, the plants are also found in a far more acid surrounding, therefore, *C. castanocarpa* is more likely to be a very tolerant species capable of growing in a wide variety of soils. Flowering and fruiting whole year through.

Uses: In N. E. Malaysia (Kelantan and Trengganu) the young leaves are cooked and eaten as spinach or chopped up with rice (Corner, 1940). The wood is used as a non-construction timber by the Iban, Sarawak, Borneo (Jarvie & Perumal, 1994), for building purposes in Ceylon (Gamble, 1902), and for sampans and columns in Indochina (Gagnepain, 1926). The wood is said to be light red, moderately hard, close-grained, pores small, scanty, in short radial lines, medullary rays very fine, very numerous, narrow wavy concentric bands fairly regular and prominent (Gamble, 1902).

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Malesian vernacular names: Malaysia: *Batu membatu* (Corner, 1940). Sumatra: *Besie*, *Kaju besi*(e) (Malay). Borneo: *Dengin-bobok* (Bassap-Mapulu); *Dusun bukit* (Tidong); *Kaju dusun*, *Nampadu* (Malay); *Masam* (Serwak-Dyak); *Mauhi* (Bajar Malay); *Medang serukan* (Brunei Dusun); *Pingas* (Sungei); *R'teh r'teh* (Medong Serokan); *Boekir*, *Djamilas*, *Djentian*, *Oebar bantan*, *Perupuk batu* (Kalimantan area); *Obah nasih* (Sandakan Prov).

Notes: O. Kuntze (1891) made a new combination in the genus *Gaedawakka* L. (Fl. Zeyl., 1747, 203). This combination is superfluous, because the description of *Gaedawakka* predates the starting date of 1 May 1753 (art. 13. 1a, I.C.B.N. 1988).

One specimen with female flowers (*Forest Guard* 3, Malaysia, BM) showed 3 filaments attached to the gynophore, all other female flowers were devoid of stamens.

The species is fairly constant, the infraspecific variation is quite narrow. Leaves in Malaysia are usually much larger than those in Sumatra, with the Bornean specimens in between. The pilosity varies, plants in Malaysia are (early) glabrous, while on Sumatra and especially in NE Borneo the leaves can be subpilose and the branches pilose, although glabrescent. In Borneo the leaves tend to be more elliptic than ovate (Malaysia, Sumatra). The male flowers in Malaysia are usually much larger than those in Sumatra, also with the Bornean specimens in between.

Acknowledgements

The Directors of A, BM, BO, F, G, K, L, MO, NSW, NY, P, UC, and US are thanked for loan of their material or for enabling me to visit their institutes.

I like to thank V. V. Sivarajan, Peter Bass, and Marco Roos for reading the manuscript. I am obliged to Jan van Os for the beautiful drawing. Max van Balgooy kindly determined wrong identifications.

The map was made with the map drawing program KORT (© Bertil Hansen, C) and the coordinates database COOR (© Peter van Welzen, L).

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 Pax, F. 1890. Euphorbiaceae. In: A. Engler & K. Prantl (eds.), *Die Natürlichen Pflanzenfamilien* Leipzig. 3, 5: 1-119.
 Roxburgh, W. 1832. *Flora Indica*, London. 3: 848, 849.
 Thwaites, G. H. K. 1854. Descriptions of some new Genera and Species of Ceylon plants. *Hooker's J. Bot. Kew Gard. Misc.* 6: 300, 301, fig. XA.
 Thwaites, G. H. K. 1861. *Enumeratio Plantarum Zeylanicae*, London. 274-275.

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Identification List

Material of *Chaetocarpus* studied (1=*Chaetocarpus castanocarpus* (Roxb.) Thwaites; 2=*C. coriaceus* Thwaites; 3=*C. pubescens* (Thwaites) Hook. f.):

A series 3705a: 1—*Agama* 534: 1, *Agullana* 1951: 1, *d'Alleizette* 6538: 3, *Alston* 13287: 1, *Ambri & Arifin* W 80: 1; W 557: 1; W 931: 1, *Anonymous* 238: 1, *Anta* 528: 1, *Balansa* 3238: 1, *van Balgooy* 2234: 1; 2235: 1; 2236: 1; 5813: 1; 6073: 1; 6140: 1, *van Balgooy & Kessler* 5925: 1, *van Balgooy & van Setten* 5490a: 1—bb series 4194: 1; 7453: 1; 14575: 1; 16261: 1; 16496: 1; 16498: 1; 16735: 1; 16751: 1; 16784: 1; 18303: 1; 18848: 1; 18858: 1; 24740: 1; 26159: 1; 26224: 1; 29350: 1; 29372: 1; 29373: 1; 33979: 1; 34109: 1; 34330: 1; 34365: 1; 34403: 1; 34420: 1; 34423: 1; 34684: 1, *Beccari* P 3 1113: 1, *Bernardi* 15717: 1—*van Beusekom & Phangkhal* 2659: 1, *van Beusekom & Santisuk* 2824: 1—EKF series 42120: 1; 57628: 1—BRUN series 3391: 1, *Cambell* 61: 1, *Chand* 2500: 1; *Chin* 2155: 1, *Collins* 326: 1; 769: 1; 2005: 1, CP Series 1025: 2; 2641: 1; 3013: 3—*Cramer* 3393: 2, *Curtis* 658: 1; 658: 1; 725: 1, *Dickason* 6553: 1; 6969: 1, *Doctars van Leeuwen* 10234: cf 3, *Elmer* 21051: 1; 21054: 1; 2132: 1, *Enchai* 9875: 1, *Endert* 4833: 1, *Forest Guard* 3: 1, *Geesink & Hiepko* 7829: 1, *Geesink & Phengkhal* 6303: 1, *Geesink & Santisuk* 4995: 1; *Geesink, Hattink & Phengkhal* 6491: 1, *Hamid* 3774: 1, *Haniff* 41: 1; 150: 1; 238: 1; 355: 1; 15638: 1, *Haniff & Nur* 3817: 1; 3892: 1, *Hansen & Smitinand* 11923: 1; 12188: 1; 12471: 1; *Hardial & Samsuri* 199: 1, *Hosa* 670: 1, *Jacobs* 5463: 1, *Jaysuriya & Bandaranaike* 1807: 2; 1854: 1; 1862: 1, *Kamla* 16540: 1, *Kato & Wiradinata* B-7144: 1, KEP series 98635: 1; 99664: 1—KEP FRI series 431: 1; 684: 1; 6914: 1; 12993: 1; 13693: 1; 14367: 1; 21790: 1—Kerr 2057: 1; 2072: 1; 7824: 1; 8374: 1; 9364: 1; 9410: 1; 9570: 1; 11323: 1; 11642: 1; 12648: 1; 13586: 1; 14071: 1; 14205: 1; 16540: 1; 16614: 1; 19857: 1; 20933: 1—Kiah 24361: 1—King's collector 204: 1; 581: 1; 1392: 1; 5077: 1—*Kostermans* 5777: 1; 6362: 1; 6396: 1; 7236: 1; 7953: 1; 8614: 1; 8642: 1; 9123: 1; 10088: 1; 10809: 1; 12739: 1; 13946: 1; 21097: 1; 21252: 1; 23312: 1; 24115: 1; 24764: 1; 25465: 1; 25525: 1; 25537: 1; 25539a: 3; 26720: 1; 27143: 1; 27311: 2; 27313: 1; 27645: 1; 28039: 1; 28431: 2, *Kostermans & Anta* 130: 1; 233: 1; 513: 1; 528: 1; 710: 1; 953: 1; 954: 1; 990: 1, *Lakshnakara* 503: 1, *Larsen, Larsen, Nilsen & Santisuk* 31209: 1, *Leighton* 111: 1, *Maidin* 4578: 1, *Mingay* KD 1398: 1, *Martin* 407: 1, *Maxwell* 72-7: 1; 74-1089: 1; 85-333: 1; 85-1034: 1, *Meijer* 130297: 1, *Motley* 114: 1, *Murata, Fukuoka & Phengkhal* T-17567: 1; T-17798: 1, *Nitrasirak* 417: 1, *Niyomdham* 1691: 1, *Orolo* 26: 1; 4669: 1, *Panigrahi* 22506: 1, *Parker* 2340: 1, *Paymans* 274: 1, *Phengnaren* 504: 1, *Pierre* 310: 1; *Poilane* 911: 1; 2487: 1; 11799: 1; 14566: 1; 14571: 1, *Prapat* 144: 1, *Put* 505: 1; 725: 1; 2312: 1, *Ridley* 12620: 1; 14939: 1, *Ruengsaim* 18: 1, S series 945: 1; 7869: 1; 14844: 1; 16971: 1; 17301: 1; 23642: 1; 25366: 1; 26295: 1; 27017: 1; 27144: 1; 33535: 1; 39178: 1; 41964: 1—SAN series 15157: 1; 16112: 1; 17289: 1; 19227: 1; 21304: 1; 21525: 1; 21716: 1; 22806: 1; 25046: 1; 25960: 1; 26263: 1; 26281: 1; 27162: 1; 28779: 1; 29633: 1; 29642: 1; 30525: 1; 30530: 1; 30540: 1; 30576: 1; 30865: 1; 31230: 1; 31584: 1; 35970: 1; 36041: 1; 38813: 1; 40570: 1; 42012: 1; 43081: 1; 44234: 1; 47440: 1; 50371: 1; 54805: 1; 55523: 1; 57843: 1; 61304: 1; 62388: 1; 62804: 1; 63156: 1; 66188: 1; 67641: 1; 69291: 1; 71517: 1; 72478: 1; 73336: 1; 73395: 1; 77634: 1; 78360: 1; 86093: 1; 88425: 1; 89125: 1; 90385: 1; 94843: 1; 95858: 1; 96082: 1; 97089: 1; 103681: 1; 107371: 1; 108780: 1; 136198: 1—*Sangkha Chand* 1130: 1; 1560: 1, *Sauveur* 6: 1; 120: 1; I-11: 1; J-5: 1, SF 3024: 1; 3026: 1; 3374: 1; 7516: 1; 13778: 1; 33413: 1; 33469: 1; 33519: 1; 33520: 1; 35159: 1; 35730: 1; 35771: 1; 40834: 1, *Shimizu et al.* T-26272: 1, *Simpson* 2009: 1, *Sinclair & Kadim bin Tassim* 10425: 1, *Siriruga* 1009: 1, *Soepadmo & Mahmud* 1205: 1, *Soepadmo & Suhaimi* 308: 1; s 151: 1, *Stone* 6303: 1; 10918: 1; *Thorel* 1232: 1, *Wass* 927: 1, *Wallich* 7196: 1; 7596: 1; 7872: 1; 7984a: 1, *Winit* 1458: 1, *Wong* WKM 263: 1, *Wood* 1727: 1; *Yates* 1696: 1.